2019 WG Meetings

Land Ice, Paleoclimate and Polar Climate Working Groups

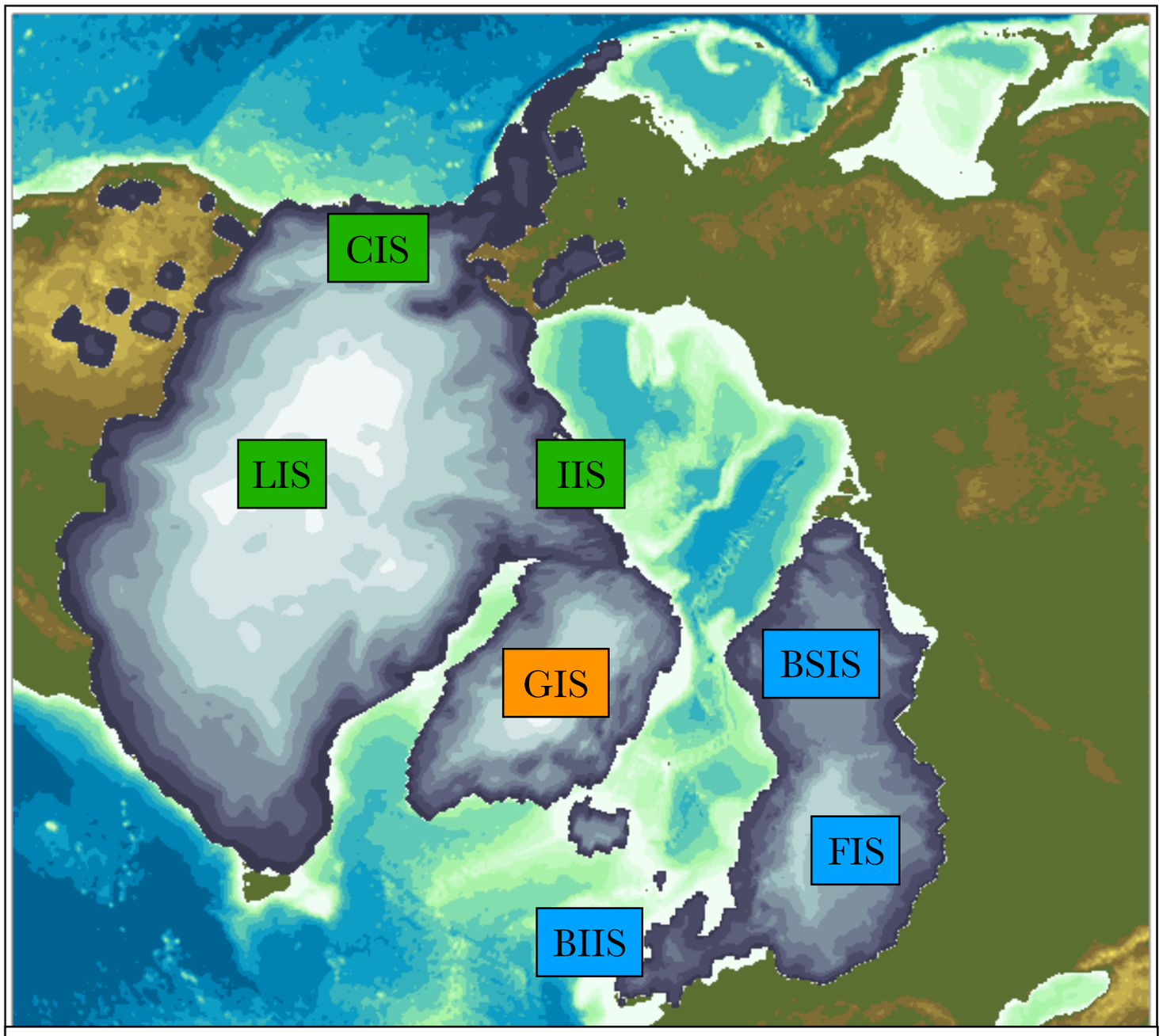
Simulating the Northern Hemisphere climate and ice sheets during the last deglaciation with CESM2.1/CISM2.1

Petrini M. & Bradley S.L

February 4, 2019

TU Delft

Study area and scientific motivations



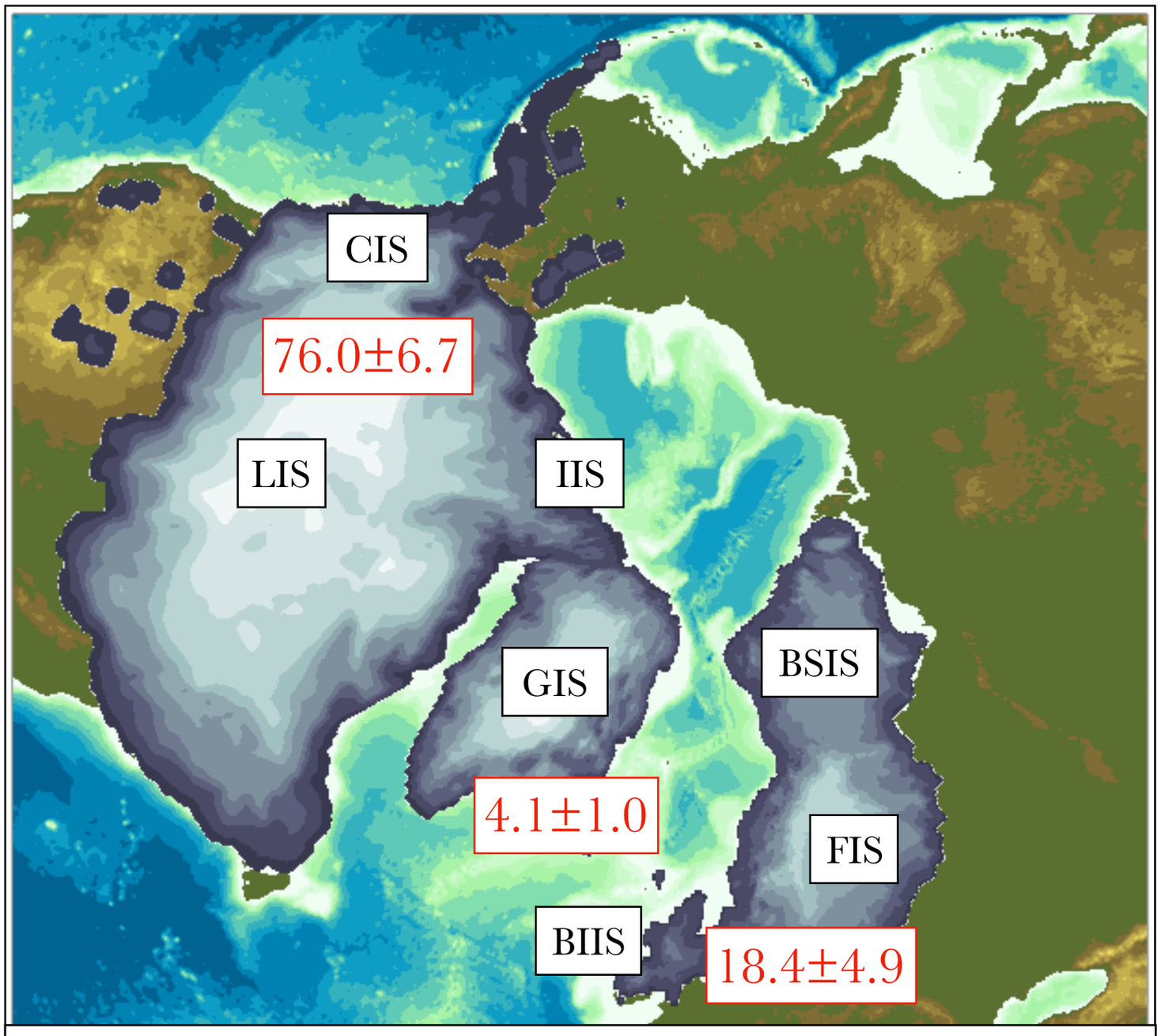
Ice sheet reconstruction for initial LGM boundary conditions, from BRITICE-CHRONO + Lecavalier et al., 2014.

Study area:

- At Last Glacial Maximum, ~21 ka, three large ice sheets: Greenland, North American, Eurasian;

Eurasian Ice Sheet complex: Fennoscandian Ice Sheet (FIS), Barents Sea Ice Sheet (BSIS), British-Irish Ice Sheet (BIIS).
North American Ice Sheet complex: Laurentide Ice Sheet (LIS), Cordilleran Ice Sheet (CIS), Innuitian Ice Sheet (IIS).

Study area and scientific motivations



Ice sheet reconstruction for initial LGM boundary conditions, from BRITICE-CHRONO + Lecavalier et al., 2014.

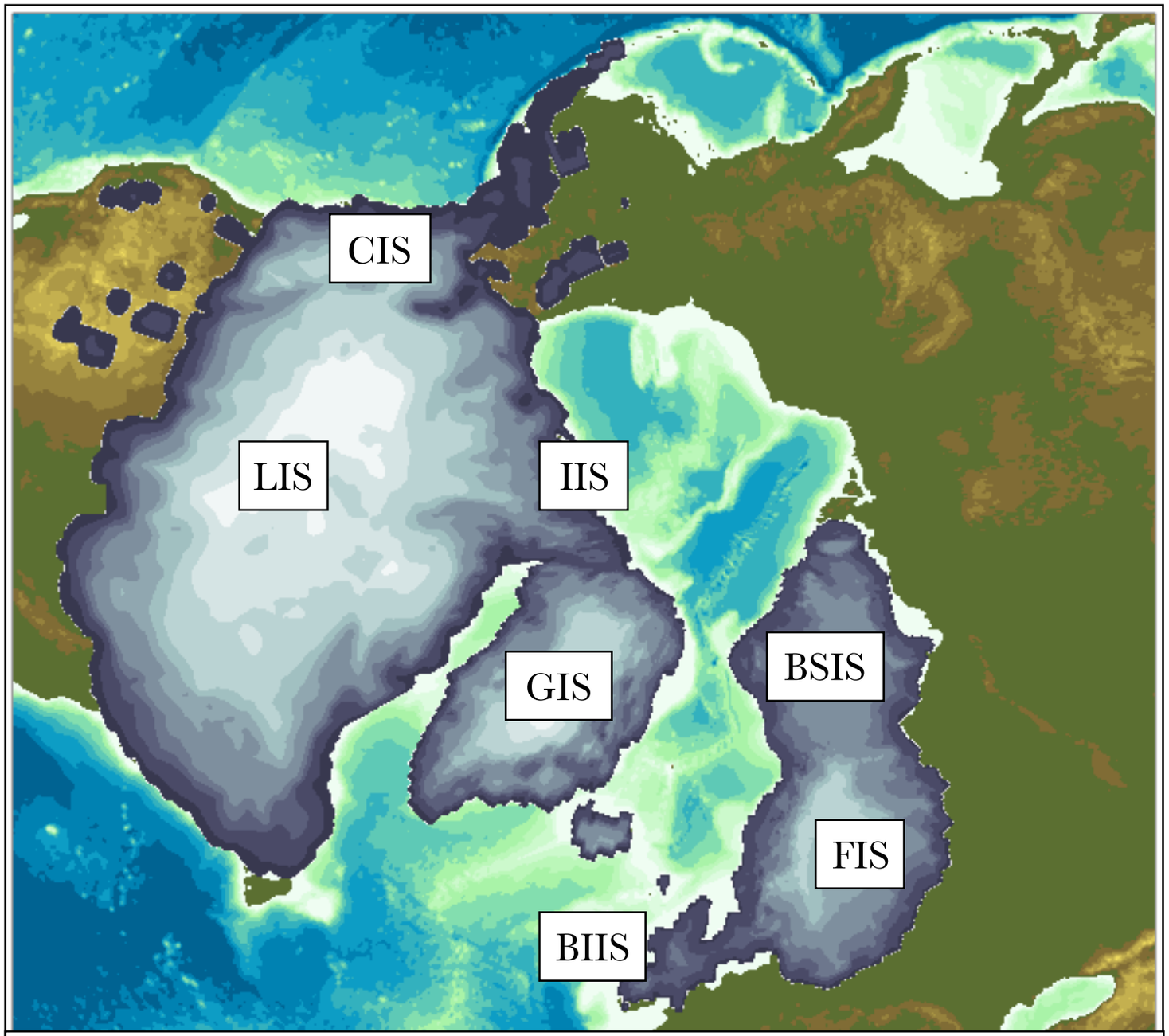
Study area:

- At Last Glacial Maximum, ~21 ka, three continental ice sheets: Greenland, North American, Eurasian;
- Sea level ~132±2 m lower:
  Eurasian: 18.4±4.9 m SLE
  North American: 76.0±6.7 m SLE
  Greenland: 4.1±1.0 m SLE.

(Simms et al., 2019 QSR)

Eurasian Ice Sheet complex: Fennoscandian Ice Sheet (FIS), Barents Sea Ice Sheet (BSIS), British-Irish Ice Sheet (BIIS).
North American Ice Sheet complex: Laurentide Ice Sheet (LIS), Cordilleran Ice Sheet (CIS), Innuitian Ice Sheet (IIS).

Study area and scientific motivations



Ice sheet reconstruction for initial LGM boundary conditions, from BRITICE-CHRONO + Lecavalier et al., 2014.

Study area:

- At Last Glacial Maximum, ~21 ka, three continental ice sheets: Greenland, North American, Eurasian;
- Sea level ~132±2 m lower:
  Eurasian: 18.4±4.9 m SLE
  North American: 76.0±6.7 m SLE
  Greenland: 4.1±1.0 m SLE.

  (Simms et al., 2019)
- Eurasian deglaciated ~10 ka

  (Hughes et al., 2016)
- North American deglaciated ~6 ka

  (Ullman et al., 2016)
- Greenland retreat to land ~8 ka

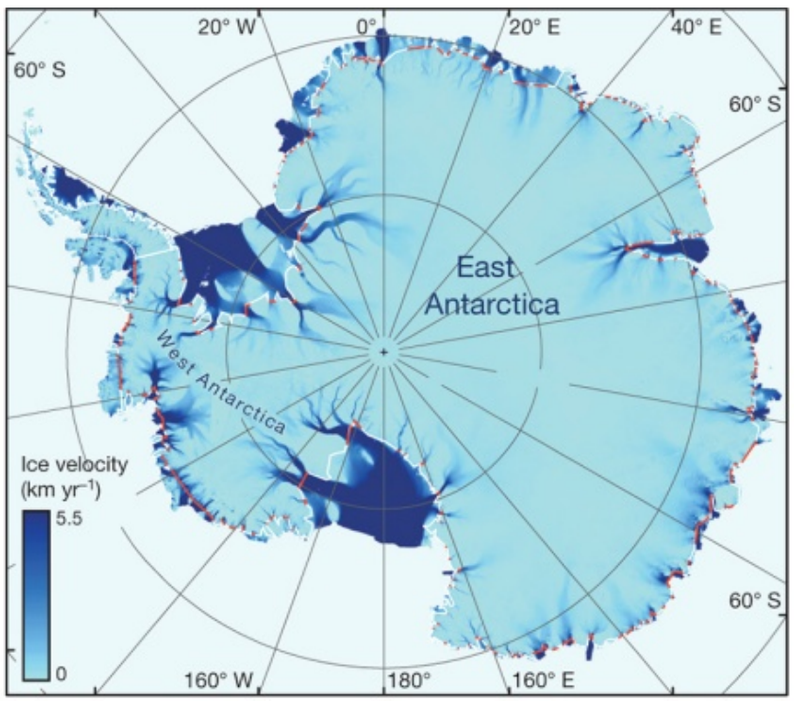
  (Georgiadis et al., 2018)

  Even smaller than today after HTM.

  (Lecavalier et al., 2014)

Eurasian Ice Sheet complex: Fennoscandian Ice Sheet (FIS), Barents Sea Ice Sheet (BSIS), British-Irish Ice Sheet (BIIS).
North American Ice Sheet complex: Laurentide Ice Sheet (LIS), Cordilleran Ice Sheet (CIS), Innuitian Ice Sheet (IIS).

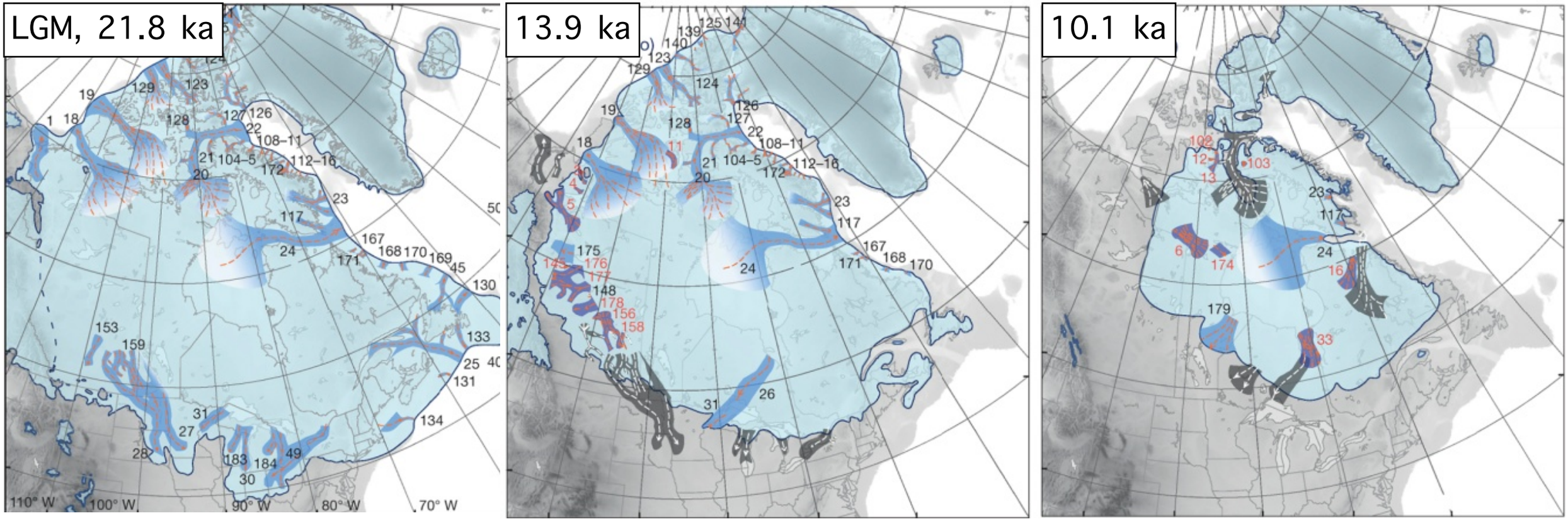
Study area and scientific motivations



Motivation:

- At LGM, 27% of Laurentide Ice Sheet margin streaming;
- Many streams drained marine-based sectors of the ice sheet;
- Percentage, size, velocity patterns similar to PD Antarctica;

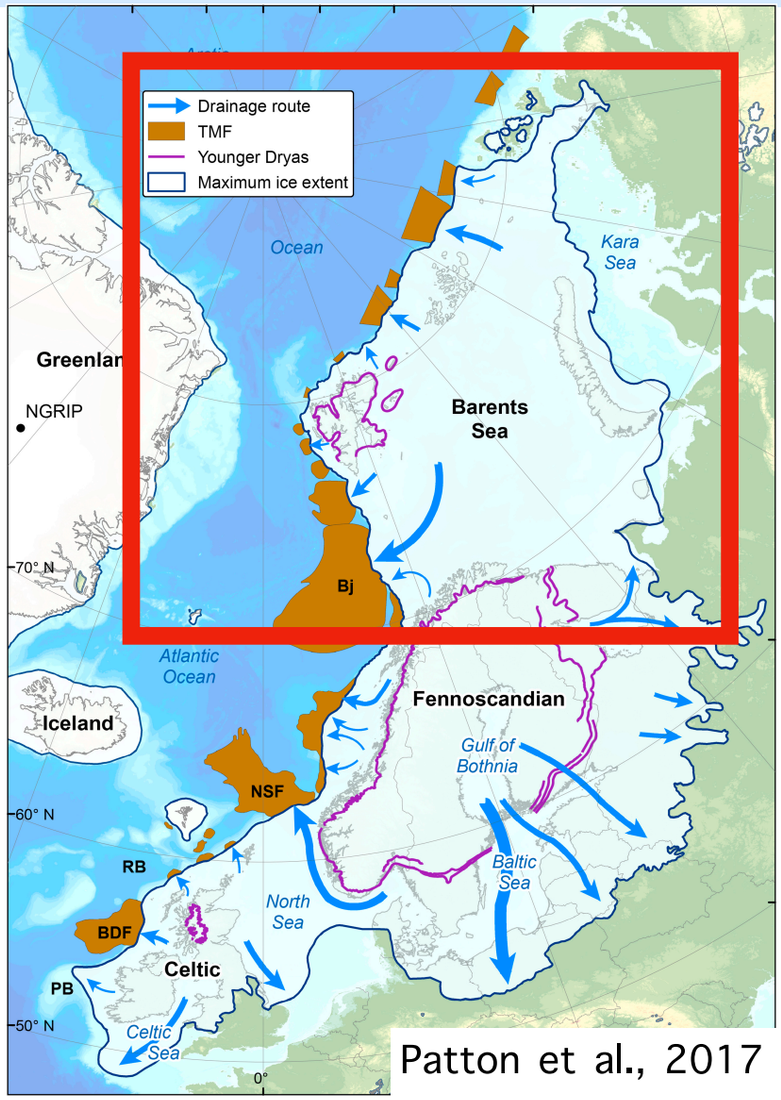
Role of ice streams in ice sheet response to climatic forcing to reduce uncertainties in sea level projections



Stokes et al., 2016

TU Delft

Study area and scientific motivations



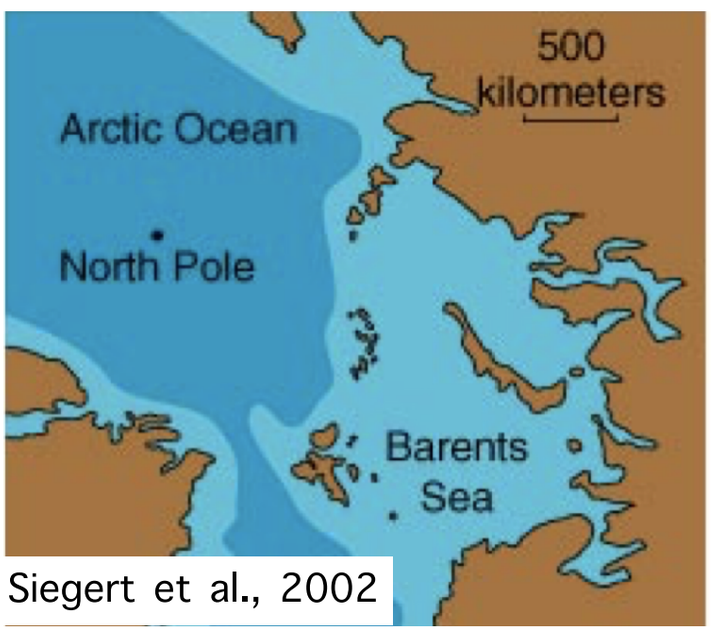
Patton et al., 2017

Motivation:

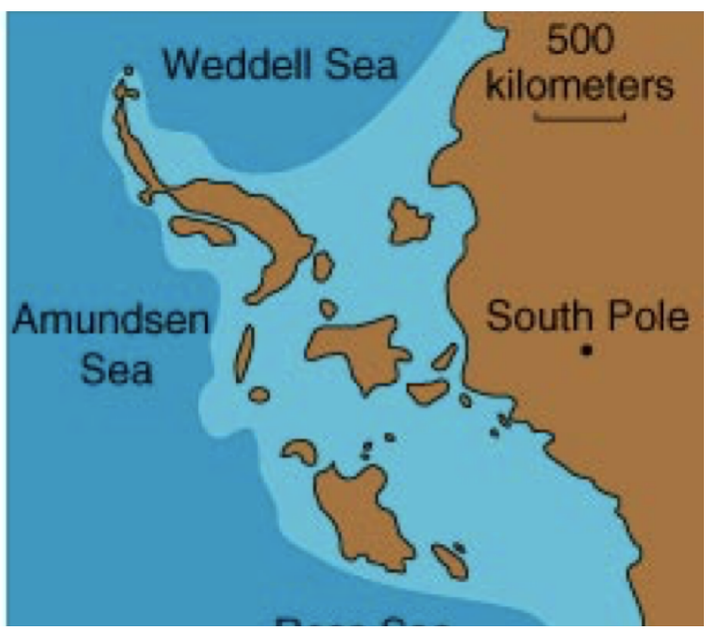
- Barents Sea Ice Sheet at the LGM entirely marine-based;
- Located on shallow, retrograde continental shelf;
- Potentially prone to Marine Ice Sheet Instability;
- Paleo-analogue for present-day West Antarctic Ice Sheet;

(Mercer, 1970)

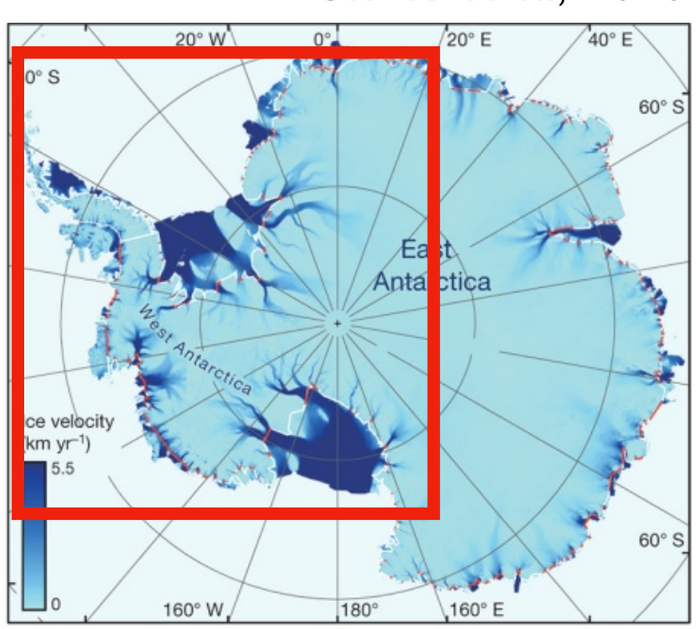
Understand processes driving last retreat of the ice sheet insights into present-day/future West Antarctic Ice Sheet



Siegert et al., 2002



Stokes et al., 2016



TU Delft

Approach: CESM2.1-CISM2.1 coupled simulations

Atmosphere

CAM5

Resolution: FV1

Land

CLM2

Resolution: FV1

Ocean

POP2

Resolution: FV1

Ice sheets

CISM2.1

Domain: NH

Resolution: 4 km

10 elevation classes

1/10 CESM/CISM

SMB, T_{air}

Approach: CESM2.1-CISM2.1 coupled simulations

Atmosphere

CAM5

Resolution: FV1

Land

CLM2

Resolution: FV1

Ocean

POP2

Resolution: FV1

Ice sheets

CISM2.1

Domain: NH

Resolution: 4 km

10 elevation classes

1/10 CESM/CISM

Sub-shelf melt

SMB, T_{air}

T_o, S_o

Ongoing work!

TU Delft

Approach: CESM2.1-CISM2.1 coupled simulations

Approach: CESM2.1-CISM2.1 coupled simulations

Ongoing and future work:	Timeline
• Development of a new paleo-toolkit for CESM2.1;	February 2019
• Run LGM climate with fixed ice sheets (B-run);	Feb/March 2019
• Perform TG-runs with LGM climate to calibrate CISM2.1;	April/May 2019
• Run LGM climate + interactive ice sheets (BG-JG run);	June 2019
• Transient BG-JG-runs of deglaciation from 21 to 10 ka;	September 2019

CISM stand-alone runs of Northern Hemisphere